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Diamond Light Source Proceedings / Volume 1 / Issue MEDSI-6 / October 2011 / e3
DOI: 10.1017/S2044820110000110, Published online: 29 September 2010

Link to this article: http://journals.cambridge.org/abstract_S2044820110000110

How to cite this article:

X. Wang, H. Du, Z. Yan and L. Yin (2011). Research on ground vibration of the Shanghai Synchrotron Radiation Facility. Diamond Light Source Proceedings, 1, e3 doi:10.1017/S2044820110000110

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Poster paper

Research on ground vibration of the Shanghai Synchrotron Radiation Facility

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(Received 18 June 2010; revised 18 August 2010; accepted 26 August 2010)

Ground vibration is a key issue for the Shanghai Synchrotron Radiation Facility (SSRF), which is a third-generation light source under commissioning. However, the ground vibration of the SSRF is much larger than other light sources for relatively softer soil and deeper bedrock. More than 1000 piles with 0.6 m diameter down to 48 m underground, and slabs of 1450 mm thickness for the storage ring tunnel and the experiment hall, have been used to attenuate the ground vibration. Measurement results show that these piles and slab have obvious attenuation effect for the vibration induced by nearby vehicles and air conditioners. The coherences with respect to different distances are also carried out.

1. Introduction

The electron beam stability is a very important issue for the third-generation light sources, especially for the Shanghai Synchrotron Radiation Facility (SSRF), whose ground vibrations are much larger than others (Lianhua 2006). The storage ring is 432 m in circumference and the ground-vibration requirement for the foundation design is that the vertical amplitude is less than 300 nm in noise time and 150 nm in quiet time. Figure 1 shows the sites of SSRF building located about 50 m south of Cailun road, 65 m north of Zhangheng road, 150–200 m east of Huatuo road and 250–300 m west of Keyuan road, respectively. Attenuating the ground vibration is a crucial problem for the design of the SSRF foundation.

2. The design of SSRF foundation

Figure 2 shows the photograph of the SSRF foundation, which is divided into the following five parts from the outside to the inside in sequence: outer building, outer technical corridor, experiment hall, the storage ring tunnel, inner technical corridor and inner building (see figure 1). According to the conclusion that the barriers of slab and piles can effectively attenuate the ground vibration (Andersen & Nielsen 2005) together with the possible of project implementation and financial budget, we have finally decided to use about 1000 piles with 0.6 m diameter down to 48 m underground, and slabs of 1450 mm thickness for the storage ring tunnel and

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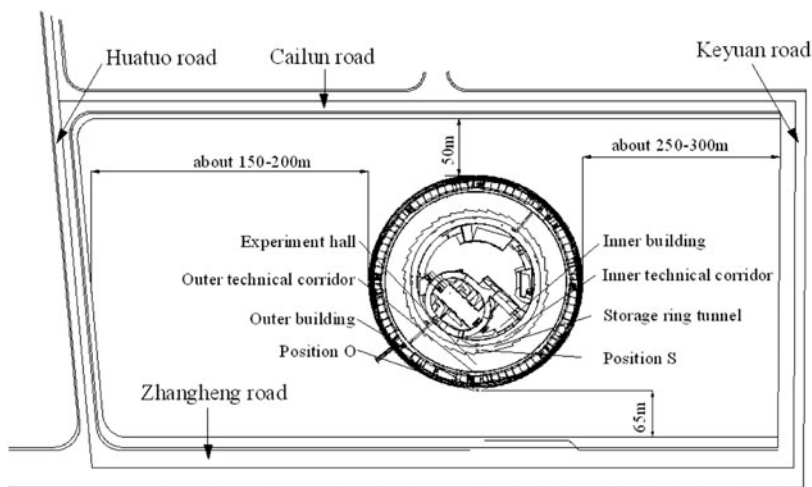


FIGURE 1. Layout of SSRF site.

the experiment hall, 400 mm for the inner technical corridor and 120 mm for the outer technical corridor. There are no slabs and piles for the outer and inner buildings. To the author's knowledge, no such thick slabs or so many piles are used in other third-generation light sources.

3. Research on the ground vibration at the SSRF

In order to investigate the vibration-attenuation effect by the SSRF foundation, six seismometers were divided equally into two groups to place the outer building (position O in figure 1), which is situated in the vicinity of the foundation without barrier, and the storage ring tunnel (position S in figure 1), whose vibration we were most concerned about at the design stage. The measurement positions O and S are as close to the Zhangheng road as possible to adequately reflect the influence of the vehicles. During the measurement, we assigned a 10-tonne truck on the Zhangheng road at midnight to reduce the influence of environmental noise. Figure 3 shows the displacement power spectrum density (PSD) spectra of the



FIGURE 2. Photograph of SSRF foundation.

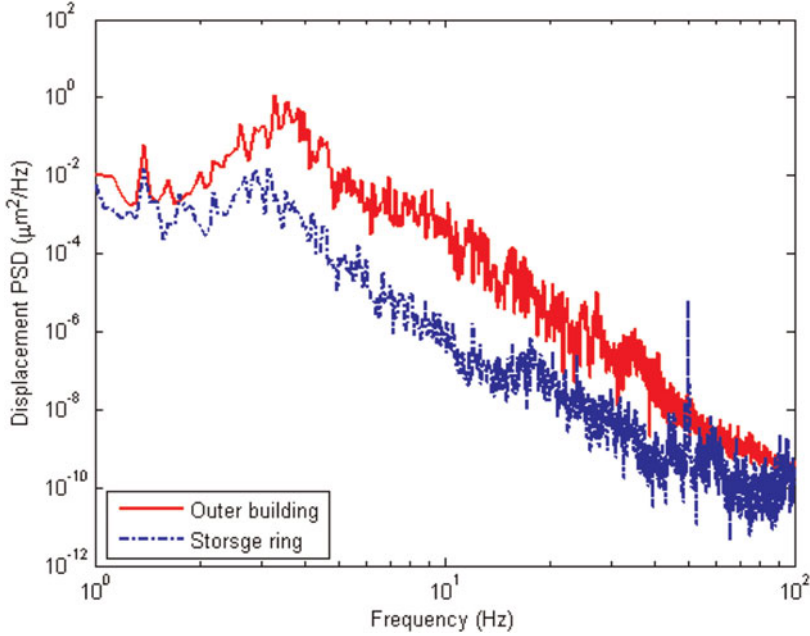


FIGURE 3. Displacement PSD with 10-tonne truck.

storage ring, from which we find that the foundation effectively attenuates the vibration induced by the vehicles, especially the body-bounce natural vibration frequency 2.5 Hz (Xu & Hong 2008), which is suppressed by two orders by the foundation. Another peak, nearly 1.3 Hz (Lianhua 2006), which is the inherent characteristic of the SSRF site, however, remains almost constant.

There are six air conditioners (AC), which also concern the vibration sources when the light source is working. Measurement for one of the ACs is also performed. The measurement points are situated in the AC room (inner technical corridor) and storage ring tunnel, respectively, with the distances between them no more than 6 m. Figure 4 displays the displacement PSD spectra of the two positions with respect to the AC being on and off. Although the AC has significant influence on the AC room, it has much less influence on the storage ring tunnel, which results from the fact that the foundation of the latter is much better than that of the former. In addition, the foundation of the storage ring has effectively suppressed the peak values such as 18, 28 Hz, etc. which is mainly caused by the AC.

In addition, coherences of the ground vibration of the storage ring are also shown in figure 5. Here, three cases with different distances are measured: among them, distance 5 m is approximately equal to the length of the magnet girder assemblies (MGAs) of the storage ring; 10 and 15 m are about the distances of the adjacent MGAs and between the first and the last MGAs within a cell, respectively. From the figure, we can find that the coherence of the ground vibration for the first case can arrive at 0.8 at a frequency of about 22 Hz, which is about the first eigenfrequency of the longest and heaviest MGAs (Xiao *et al.* 2008); those for the second and third cases, however, are dramatically decreased to 0.3–0.7. So the magnet vibrations within one MGA have good consistencies with each other, while for different MGAs, the consistencies will become much worse.

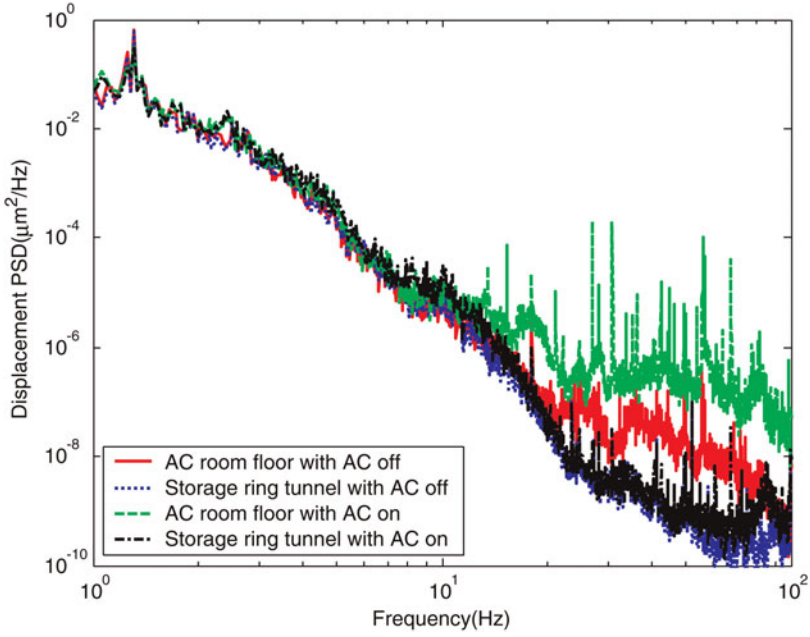


FIGURE 4. Ground vibration with AC on and off.

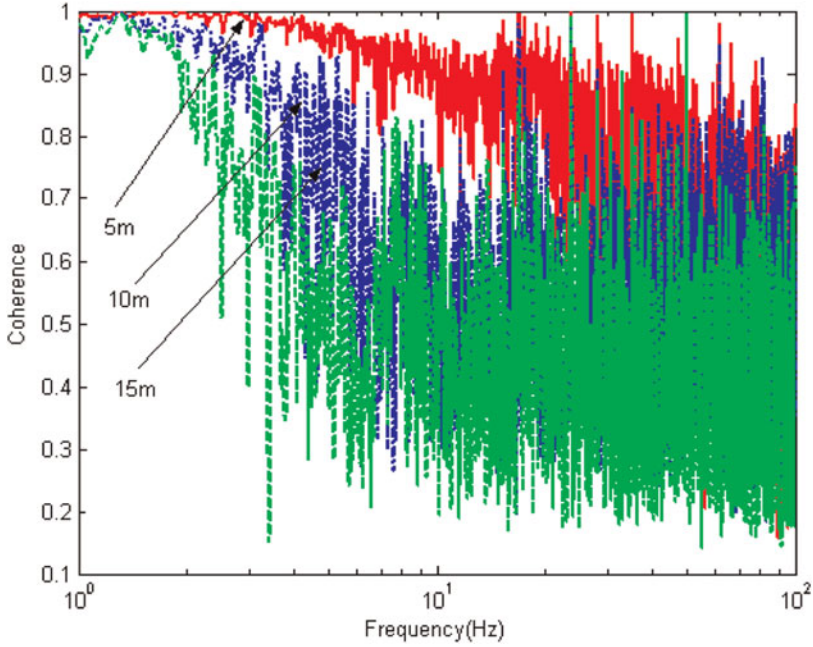


FIGURE 5. Coherence of the ground vibration.

4. Conclusion

The paper concentrates on the research of the ground vibration of the SSRF. The SSRF foundation, by using about 1000 piles with 0.6 m diameter down to 48 m underground, and slabs of 1450 mm thickness for the storage ring tunnel and the

experiment hall, has obvious attenuation effect for the vibration induced by vehicles and the AC. In addition, the magnet vibrations within one MGA have good consistencies with each other by the coherence analysis of the ground vibration.

Acknowledgements

This work was supported by the National Nature Science Foundation of China under Grant no. 10805072.

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